2006 Integrated Report to Congress on Water Quality in Kentucky

Volume I. 305(b) Assessment Results with Emphasis on the Kentucky River Basin Management Unit and Salt – Licking Rivers Basin Management Unit

Kentucky Environmental and
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Division of Water
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ACKNOWLEDGMENTS

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Chapter 1. Introduction

The 2006 Integrated Report (IR) was prepared by the Kentucky Division of Water (KDOW), Department for Environmental Protection (DEP), for submittal to the U.S. Environmental Protection Agency (EPA) to fulfill requirements of sections 303(d), 305(b) and 314 of the Federal Water Pollution Control (or Clean Water) Act of 1972 (P.L. 92-500), as subsequently amended. Section 305(b) of the Act requires states to assess and report current water quality conditions to EPA every two years.

It is anticipated that by integrating the two reports users of the information will find this comprehensive reporting medium of greater utility by having all relevant information woven together in two volumes: Volume 1 containing assessment and data analyses (305(b) portion) and Volume II containing the 303(d) listing and relevant information. The use of assessment categories in which to file assessed stream segments and lakes/reservoirs provides an accurate and convenient method to track the miles (or acres) of assessed and non-assessed uses, while also tracking those impaired waters from the time of 303(d)-listing through the TMDL process.

Currently, KDOW is utilizing the assessment database (ADB) to store use assessments and aid in producing the various tables and compilation of statistics presented in this report. As with previous 305(b) reports, ADB provides assessment data of stream segments and locational data (GNIS and latitude/longitude) used to georeference those data. This has proved to be an efficient mechanism to produce the reach-index maps. In addition to the ADB, the TMDL section has developed a database based on the ADB to track 303(d)-listed waterbodies. This database is updated to reflect the TMDL development, approval, and delistings of those waters/segments, and this information is downloaded into ADB for 303(d) reporting purposes.

The KDOW initiated a five-year rotating watershed management approach in 1997. Results from the first basin management unit (BMU), the Kentucky River, were reported in the 2000 305(b) report. This IR focuses on monitoring efforts from the first two years of the second cycle of the BMU monitoring strategy: the Kentucky River and Salt-Licking Rivers BMUs. These BMUs were monitored in 2003 and 2004, respectively. The report also presents a summary of data from the entire state, including the first five year cycle of monitoring and analysis under the BMU framework. Data collected by the Ohio River Valley Water Sanitation Commission (ORSANCO) were used to make assessments for the main stem of the Ohio River.

Impaired waters in these two BMUs, along with those identified in the 2004 305(b) report (Kentucky Division of Water, 2004) from the Big Sandy-Little Sandy-Tygarts BMU, are listed in the 303(d) section of this IR. The 303(d)-list has approximately 5160 miles from 910 segments that are in category 5 (assessment category for impaired waters that require a total maximum daily load (TMDL) set for the nonsupporting use. For the first time, intensive monitoring from the Big Sandy-Little Sandy-Tygarts BMU was made in 2003, with results reported in the 2004 305(b) report. Thus, the 2006 IR contains waters 303(d)-listed from that BMU which resulted from that monitoring. This region contains the largest coal reserves in the state, primarily in the Big Sandy River Basin. There are approximately 780 miles of rivers and streams 303(d)-listed from the Big Sandy-Little Sandy-Tygarts BMU in this IR.

There are reasons that some impaired waters are not 303(d)-listed. For example, evaluated data from discharge monitoring reports (DMRs) from permitted facilities are not on the 303(d)-list because, through permit compliance, these facilities should not be the source of pollutants at sufficient levels to preclude assimilation at concentrations specified for each pollutant in a given permit; also, these DMR data were not directly monitored instream, but at the outfall.

Chapter 2. Background

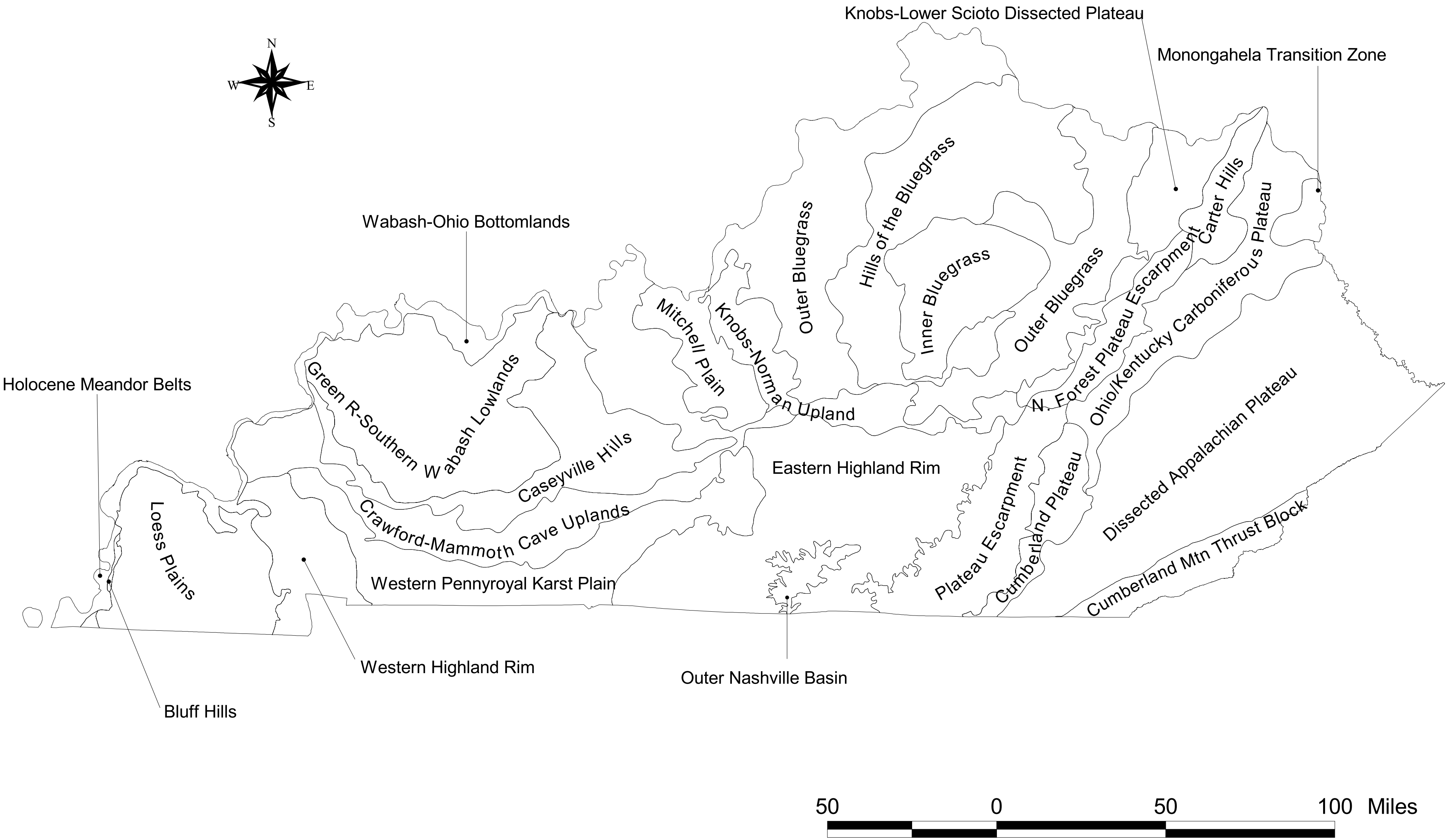
2.1 Atlas of Kentucky's Water Resources and Profile of Select Demographic and Physiographic Statistics

Atlas of Kentucky	
State population (2004 estimate)	4,145,922
Surface area (square miles)	40,409
Number of counties	120
Number of level III ecoregions	7
Number of level IV ecoregions	25
Number of major basins	12
Number of USGS 8-digit HUCS	42
Number of stream miles (1:24,000 NHD)	90,961
Number of stream-formed border miles (primarily Ohio River)	861
Number of publicly owned lake and reservoir surface acres (estimated)	229,500
Three largest reservoirs by surface acres	
Kentucky Lake (Kentucky portion)	57,103
Cumberland Lake	47,623
Barkley Lake (Kentucky portion)	42,780
Wetland acres[1] (approximation)	324,000

[1]"The state of Kentucky's environment: 1994 status report." The Kentucky Environmental Quality Commission, 1995.

The physiography of Kentucky provides for a landscape of 25 Level IV Ecoregions (Figure 2.1-1) that are diverse geologically and physically and provide a variety of microclimates that are important in forming and supporting diverse plant and aquatic communities. This rich aquatic biodiversity is a part of the southeastern aquatic environment that provided long, stable conditions due to this region being non-glaciated. While the state has many miles of streams and rivers, natural lakes are uncommon and are found along the Lower Ohio and Mississippi rivers in the Jackson Purchase (region west of Tennessee River (Reservoir)); most of these lakes were formed by oxbows or shallow depression basins. Many of the major rivers in the commonwealth have been dammed for flood control and secondarily for generation of electricity. This change has affected the natural aquatic communities of these systems while providing drinking

Figure 2.1-1. Level IV Ecoregions of Kentucky.



water supplies, tourism and recreational opportunities. While only a portion of wetlands exist from what was estimated to have occurred historically (1.5+ million acres), loss of wetland acreage has slowed since federal and state regulations and disincentives for altering wetlands have been in place (The Kentucky Environmental Quality Commission, 1995). By river basin, the Green River has the largest proportion of remaining wetlands (approximately 88,000 acres). As indicated by the number of caves in Kentucky, there are significant karst areas in many areas of the state, but the largest karst landscape exists in the Green River Basin, which includes Mammoth Cave. These areas of karst present special concerns for water quality protection since groundwater flows may be unknown and underground rivers are difficult to monitor because of limited access.

2.2 Programmatic Framework

In order to better characterize the waters of the state, and better coordinate resources toward addressing problems, Kentucky adopted a Watershed Management Framework in 1997 (Figure 2.1-1). The purpose of this management framework is to use programs, people, information, and funds as efficiently as possible to protect, maintain, and restore water and land resources. This approach provides a framework in place and time within which participating individuals and institutions can link and support one another's efforts in watershed management.

Coordinated, multi-agency watershed monitoring was initiated in 1998 in the Kentucky River Basin, and monitoring for the first five-year watershed cycle was completed in 2002. The first cycle of monitoring focused on obtaining, for the first time, a snapshot of conditions of Kentucky’s waters, especially wadeable streams. Most local, state, and federal agencies in Kentucky with monitoring responsibilities cooperated in the watershed monitoring effort. Some agencies simply provided their data and carried out monitoring as usual; others revised their sampling programs and sampling methods for better fit with the watershed monitoring plan. In early 2005, the Kentucky Department for Environmental Protection and the Tennessee Department of Environment and Conservation formally agreed to begin cooperating and sharing combined resources to work toward making tangible improvement to shared watersheds. For example, several watersheds (Clarks River, Red River and Upper Cumberland) were identified to have interstate concerns and probable shared sources of pollutants or pollution affecting stream health. Currently, monitoring is going on to identify sources and spatial and temporal concentrations of nitrates in the Red River watershed in the Lower Cumberland River basin. In addition to scoping and fixing pollutant-source issues, an effort has been agreed upon whereby each state will identify shared high quality watersheds then establishing them as such in their respective regulations. Additionally, where one state has already identified high quality waters crossing the state boundary, but the other has not, that state will assess their portion of the stream and determine if it qualifies for elevation to high quality designation.

According to the adopted framework, the state is divided into five basin management units (Figure 2.2-1) for the purposes of focusing management activities spatially and temporally. Activities within each unit follow a five-year schedule, staggered by one year, so that efforts can better be focused within a basin. Phases in the cycle include: 1) collecting information about water resources in the basin; 2) identifying priority watersheds; 3) listing the watersheds in the basin in order of priority and deciding which problems can be solved with existing funds; 4) determining how best to solve the problems in the watershed; 5) developing an action plan; and 6) carrying out the strategies in the plan (Figure 2-3). Public participation is also encouraged throughout the process, allowing citizens and organizations to stay informed and have an active role in management of resources. Monitoring and assessment take place in the second and third years, respectively, of the watershed cycle.

Figure 2.2-1. Kentucky Basin Management Units and monitoring years of the second five-year cycle.

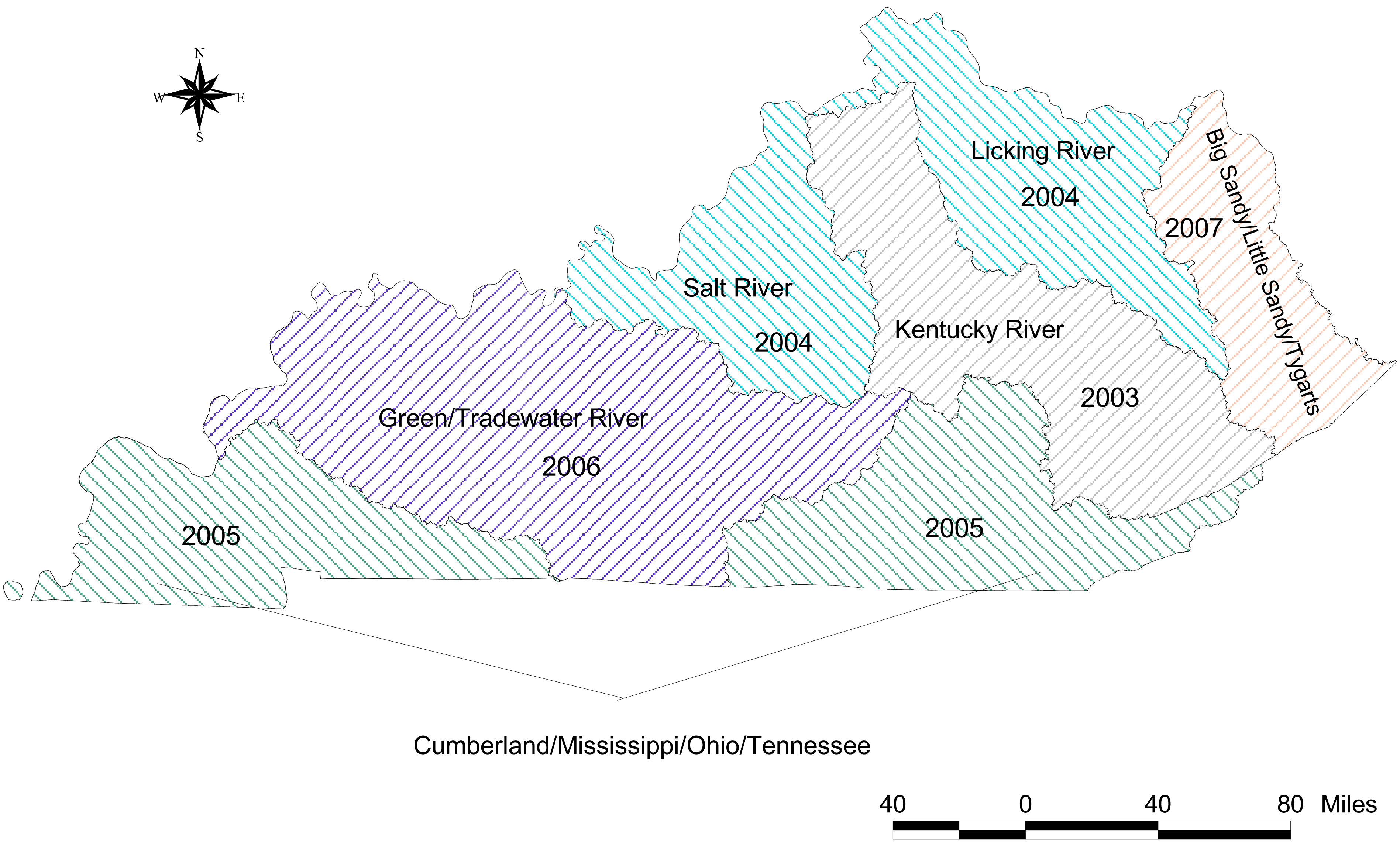
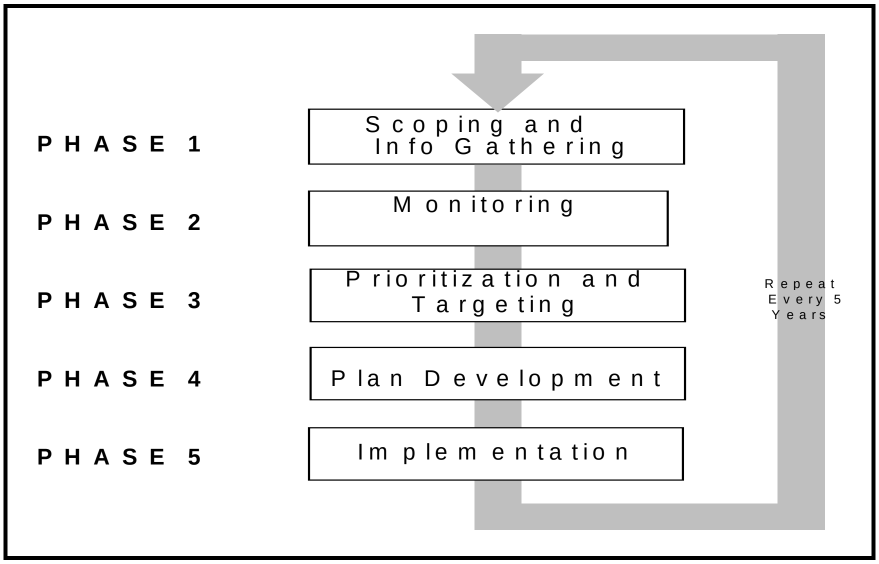


Figure 2.2-2. Planning, monitoring and implementation phases of the basin management unit approach.



Each basin was phased into the Watershed Framework schedule as listed below. Monitoring activities begin in the second year of the cycle.

- July 1997 – Kentucky River basin
- July 1998 – Salt and Licking river basins
- July 1999 – Upper Cumberland River and 4-Rivers (Lower Cumberland, Ohio, Mississippi and Tennessee rivers) basins
- July 2000 – Green and Tradewater rivers basins
- July 2001 – Big Sandy River, Little Sandy River , and Tygarts Creek basins

Benefits of this approach include:

- Better coordination of resource management activities around common basin management units and schedules.
- Better ability to stretch limited dollars for implementation activities through partnering.
- Better information about water resources without higher monitoring costs.

- More data as monitoring efforts are coordinated – approximately a four-fold increase in assessment data has been realized since the inception of the watershed approach in 1998.
- Better data as agencies standardize methods and procedures.
- Greater opportunities for citizen involvement.

The 2004 305(b) Report represented the completion of the first monitoring and assessment cycle of the five BMU management framework. Whereas the purpose of monitoring in the first watershed cycle was to obtain baseline data statewide, monitoring in the second cycle (begun in 2003) focuses more on impaired watersheds. However, ambient monitoring continues at long-term stream and lake stations, watersheds not sampled in the first watershed cycle, random survey sites, and on small streams to refine reference reach metrics. Much of the work is done sequentially to make best use of monitoring personnel and to collect data during the target index period according to stream sizes. The following is the cycle beginning with planning phase-year with the monitoring and assessment in years two and three, respectively.

- 2002 – Kentucky River Basin
- 2003 – Salt – Licking basin
- 2004 – Upper Cumberland River and 4-Rivers (Lower Cumberland, Mississippi, Ohio, and Tennessee rivers) basin
- 2005 – Green – Tradewater rivers basin
- 2006 – Big Sandy – Little Sandy rivers and Tygarts Creek basin

2.2.1 Overview of Programs Related to Monitoring and Assessment

The KDOW has the primary responsibility for monitoring and assessing the commonwealth’s water resources, and overseeing the permitting of facilities and industries that discharge point sources to waters through the Kentucky Pollutant Discharge Elimination System (KPDES).

To monitor the designated uses of Kentucky’s waters and monitor the effectiveness of various control programs, such as KPDES, KDOW has a number of monitoring programs that monitor biological and water quality indicators for 305(b) and 303(d) purposes. Table 2.2.1-1 highlights the monitoring programs and the indicators associated with each. A more comprehensive discussion of surface water quality monitoring programs follows in Chapter 3.

Table 2.2.1-1. Matrix of water resources and monitoring programs.

	[a]Long-term Surface Water	[a]Rotating Surface Water	[b,c]Targeted Biological Monitoring	[b]Reference Reach	[d]Probability Biological Monitoring	[e]Lake Monitoring	[a]Ground-water Monitoring
Streams (1st-5th order)		X	X	X	X		
Large Rivers	X	X	X				
Lakes/Reservoirs						X	
Groundwater							X
Swamps/Wetlands	--	--	--	--	--	--	--

[a]Indicators: physicochemical and pathogens

[b]Indicators: macroinvertebrates, fish, algae, physicochemical, habitat

[c]Includes some 6th order streams where wadeable and associated with ambient water quality stations

[d]Indicators: macroinvertebrates, physicochemical, habitat

[e]Indicators: physicochemical, fish kills, macrophytes, algae

For those waters requiring a Total Maximum Daily Load (TMDL) pollutant reduction, the division’s TMDL program manages this process by coordinating the monitoring and development of those discharge or load reductions necessary to bring the impaired Designated Use (DU) into full support. The primary source of pollutants affecting the commonwealth’s waters now is recognized to come from nonpoint sources (NPS). The fact that sedimentation became the leading pollutant in the 2004 305(b) cycle is a direct reflection on NPS pollution being the most significant source of degradation to the state’s waters. This is also the trend nationwide.

The primary objectives of the ambient monitoring program were to establish current conditions, long-term records and trends of water quality, biological, fish tissue, and sediment conditions in the state’s major watersheds (Kentucky Division of Water 1986). Sub-objectives were identified as determining: 1) the quality of water in

Outstanding Resource Waters; 2) background or baseline water quality conditions in streams not impacted by discharges; 3) the extent to which point and nonpoint sources affect trophic status of lakes and reservoirs; and 4) the impact of acid precipitation on water quality of lakes and reservoirs. Currently there are 71 primary water quality stations throughout the commonwealth that are monitored on a monthly frequency at each station respective of the current monitoring cycle. These stations are located at mid- and lower watershed reaches of 8-digit HUC basins. Location of stations also occurs near the inflow and outflow of major reservoirs, for example Taylorsville Lake in the Salt River basin. Those stations outside the BMU monitoring phase are monitored bimonthly. Implemented with the rotating basin approach are the rotating watershed stations. These stations are monitored for the same suite of water quality parameters the primary stations are but are monitored in smaller watersheds for a variety of reasons: 1) TMDL development; 2) characterization of water quality in reference watersheds; 3) monitoring of waters that receive permitted discharge (for instance a municipal wastewater treatment plant) to characterize upstream and downstream water quality; and 4) to characterize water quality conditions in specific land use, such as agricultural or mining areas.

KDOW's targeted biological monitoring program has a long history of determining the health and long-term water quality of stream and river resources. In addition to biological community surveys, physicochemical water quality variables are included in the monitoring program. Biological monitoring was implemented in the 1970s with significant refinement of the program as more research led to the development of biological multimetric indices (for more information go to: http://www.water.ky.gov/sw/swmonitor/sop/). A portion of KDOW's biological monitoring emphasis was shifted to development of those metrics and associated criteria through a reference reach approach. This was implemented in the 1990s based on an ecoregional effort to determine reference conditions in each basin. These waters do not represent pristine conditions, but they represent the best examples of high water quality and biological integrity in each of the four identified bioregions (Mountains, Bluegrass, Pennyroyal and Mississippi Valley – Interior River). Through this effort a network of streams, or stream reaches, have been identified throughout the commonwealth. These stream reaches are listed in water quality standards, 401 KAR 5:030, and can be accessed at: http://www.lrc.ky.gov/kar/401/005/030.htm. One to three biological communities (macroinvertebrates, fishes, or algae) are sampled per biosurvey. When one community only is used to make an aquatic life use support determination, either macroinvertebrates or fishes are utilized, typically the former.

A random biosurvey effort was initiated in 1998 with the help of EPA's technical support group in Corvallis, Oregon. Kentucky's approach is to sample macro-invertebrates once at a minimum of 50 sites in each BMU. In 2004, nutrients and additional chemical water quality variables were added to the suite of indicators used by this program. These additional data were added to aid in the development of numeric nutrient criteria, gain a more comprehensive knowledge of what ambient water quality variable values were in each BMU, and increase the confidence of each aquatic life use assessment. This program allows KDOW to report on aquatic life use support in wadeable streams for the entire state over the five year watershed cycle. Section 305(b) use support determinations made through the probabilistic biosurvey program were determined only on segments directly monitored, whereas extrapolated use support over a given BMU was made for informational, resource considerations, and planning purposes only. This program is important both on the statewide level as well as the national level, as indicated by EPA's probabilistic monitoring efforts in wadeable streams nationwide and planned lake and reservoir probabilistic monitoring. For a discussion on the probabilistic monitoring program, please refer to Section 3.1.4 of volume 1 of this report.

The lake and reservoir monitoring program began in the early 1980s as part of the Clean Lakes monitoring initiative. Currently KDOW monitors all significant publicly owned lakes and reservoirs in the state (approximately 105 water bodies). Many of the large Corps of Engineers (COE) reservoirs and Kentucky Lake (a Tennessee Valley Authority (TVA) project), are typically monitored by those respective agencies. The working relationship between KDOW and COE, Louisville and Nashville Districts, has proved to be a good cooperative effort that is beneficial to all parties by increasing available resources (e.g. COE may provide the field work and KDOW, in coordination with Division of Environmental Services (DES) provides chemical analyses).

Physicochemical and chlorophyll *a* are analyzed to determine current Trophic State status of these water bodies. Monitoring occurs three times during the growing season (spring, summer and fall) to capture the seasonal variability that occurs and reflects the trophic state of the resource. By monitoring these resources every five years, trends in water quality can be measured. This monitoring program collects data sufficient to determine aquatic life, secondary contact recreation and drinking water supply uses. Many of these resources are owned by the Kentucky Fish and Wildlife Department and are posted as “no swimming” water bodies, precluding applicability of primary contact recreation monitoring.

2.3 Costs Associated with Water Pollution

Putting a dollar figure on the costs associated with water pollution is difficult if not impossible to determine. However, the costs associated with KPDES-permitted facilities, which are primarily comprised of industrial facilities, package wastewater treatment plants, and municipal wastewater treatment plants, are in the millions of dollars considering construction, operating, maintenance, compliance, and administrative costs. Figures obtained from KDOW, Facilities Construction Branch, give some insight into the costs associated with treating household, business and industrial wastes.

Table 2.3-1. Costs to taxpayers for municipal waste water treatment facilities (planning, design and construction) for the control of pollution from houses, businesses and industries.

	Clean Water State Revolving Fund	EPA Special Appropriation Grants
FFY 2003	17,516,809	7,824,049
FFY 2004	58,198,400	10,775,950
Prior to FFY 2003	324,938,622 (first loan made in May 1989)	12,554,803 (first grant awarded in 1998)
After FFY 2004	36,594,665	31,829,314
Total	$437,248,496	$62,984,116

However, these costs are only a portion of the total costs to society. The increased cost of technology needed to treat potable water in areas of heavy siltation/sedimentation alone may result in loss of source water supply because the cost of treatment is prohibitive, while areas of organic industrial contamination may require expensive continuous carbon-based treatment. Medical and loss of productivity costs associated with various diseases that result from waterborne pollution are not accurately known. For example, consumption of fish flesh that has elevated levels of mercury carries increased health risks to children and women of childbearing age, while fish contaminated with elevated levels of PCBs carries increased cancer risks to the general population. Pollutants affect commercial fisheries where restricted consumption, or loss of resources, reduces the commercially available fish population; additionally, some members of society rely on subsistence fishing to supply a portion of their nutritional needs. Water pollution may also result in loss of revenue to governments and local businesses if recreation areas are unsafe for swimming or fishing. The shipping industry relies on barges to move many commodities around the nation, and the cost of maintaining shipping channels prone to excess sedimentation is an ongoing expense to both industries and governments.

2.4 Monitoring and Assessment Issues Facing the Commonwealth

KDOW submitted a nutrient criteria development plan in 2004 that was satisfactory to EPA. The first waters scheduled for criteria development are wadeable streams and intrastate reservoirs. Of particular need are data from the inner bluegrass (ecoregion 71l). True reference conditions are difficult to locate in this region. This particular area has high phosphate content found in the Lexington limestone layers of the plateau that, with the addition of significant inputs of nitrogen associated with intensive livestock grazing, grasslands, and urbanization and suburbanization, has resulted in nutrient-rich streams and reservoirs. The division has begun addressing this issue through increased nutrient sampling, but greater frequency is needed to capture seasonal variations and effects on stream systems.

Given the karst geology of much of the inner bluegrass, many of these streams are connected and have watersheds that are yet to be mapped and understood. Continuance of data collection and development of criteria based on the best attainable conditions will dictate nutrient numbers in this region. Collaboration with Tennessee DEC may be helpful since the Nashville Basin is similar to the inner bluegrass—both are composed of Ordovician limestone. Recent cooperative efforts between the two states may serve as a platform to investigate this issue collaboratively.

Lake and reservoir data are relatively complete and span approximately 25 years. This program continues to characterize the trophic state of these waters during the growing season; samples are collected in the spring, summer, and fall. The majority of reservoirs have remained stable according to the trophic state index (TSI), but there are trends from oligotrophic to mesotrophic occurring in several waters. The TSI (measure of biological productivity) is used extensively in lake water quality monitoring and assessment programs. This index uses chlorophyll *a* concentrations in the water to determine the TSI. As the TSI increases a more biologically productive system is represented.

Kentucky's wetlands are primarily bottomland hardwood systems that flood seasonally. This corresponds to the winter and spring rainy season. Any excess nutrients will likely have a subtle impact on these environments since the supply of water comes from flooding rivers, and inundation is ephemeral. These bottomland hardwoods naturally do not hold standing surface water for a significant time of the year.

To date, there have been no recognizable geographic patterns in mercury levels in fish tissue. A potential strategy to aid in trend recognition is moving toward a random monitoring scheme. Constraints may be put on the habitat population of interest, such as 4^{th} and 5^{th} order wadeable streams, major streams ($>5^{th}$ order), etc. Moving toward targeting specific feeding guilds and species may lead to finer resolution of contamination sources and would likely provide more informative fish consumption advisories issued to the public.

Like other states, Kentucky must allocate its monitoring resources to conduct a robust ambient monitoring program while also devoting substantial resources toward gathering the necessary data to develop TMDLs for hundreds of impaired waters. This can only be accomplished if all available funding mechanisms are utilized, such as regional and national EPA grants, 319 funds, third party data collection, and agreements with other cooperating local, state, and federal agencies such as the U.S. Geological Survey and the U.S. Army Corps of Engineers.